Pliocene vertebrate locality of Çalta, Ankara, Turkey. 2. Aves: Struthionidae

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ABSTRACT

KEY WORDS
Struthionidae,
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A species of ostrich is identified among the vertebrate faunal assemblage from
the Pliocene locality of Çalta, Turkey. This taxon referred to as *Struthio* sp. is
of a more robust type than the recent species *Struthio camelus* as based on the
dimensions of the posterior limb bones, and particularly the femur. This spe-
cies represents one of the struthioniformes that evolved in Eurasia and is
close in its morphological features to *Struthio asiaticus* Brodkorb, 1963.

RÉSUMÉ

MOTS CLÉS
Struthionidae,
Aves,
Pliocène,
Çalta,
Turquie.

Le gisement de vertébrés pliocènes de Çalta, Ankara, Turquie. 2. Aves:
Struthionidae. Une espèce d'autruche, *Struthio* sp. a été identifiée parmi les
vertébrés fossiles provenant de la localité pliocène de Çalta en Turquie. Ce
taxon est beaucoup plus robuste que la forme actuelle *Struthio camelus* par les
dimensions des os appendiculaires postérieurs, notamment le fémur. Elle
représente une des espèces de struthioniformes qui a évolué en Eurasie, et par
ses caractéristiques, elle pourrait se rapprocher de *Struthio asiaticus* Brodkorb,
1963.

INTRODUCTION

During the Miocene, Pliocene and Lower Quaternary, Anatolia (Central Turkey) has witnessed a diverse vertebrate fauna. A number of fossil-rich localities have been discovered (Sickenberg *et al.* 1975), representing a succession of twelve faunal groups consisting mostly of mammals but avian remains are very briefly mentioned as Aves indet. and as eggshell fragments. Hitherto, the only occurrence of fossil struthioniform bones in Anatolia (Turkey) that has been reported from the middle Miocene locality of Çandir (Sauer 1979) consists only of a pedal phalanx and eggshell fragments. The Pliocene locality of Çalta, Ankara, in Turkey has yielded a rich faunal assemblage of amphibians, reptiles and large as well as small mammals (Ginsburg *et al.* 1974; Sen 1977). We describe bird bones from the Çalta locality which are typical of the Struthionidae. No other bird remains have been reported from the Çalta up to now.

SYSTEMATIC PALAEONTOLOGY

Class AVES Linnaeus, 1758
Order STRUTHIONIFORMES Latham, 1790
Family STRUTHIONIDAE Vigors, 1825
Genus *Struthio* Linnaeus, 1758

Struthio sp.

MATERIAL EXAMINED. — Distal portion of a right femur (ACA-948); diaphysis of a left femur (ACA-949); lower part of diaphysis of a right femur from a young specimen (ACA-327); diaphysis of a right tibiotarsus lacking epiphyses (ACA-950); right tarsometatarsus, lacking proximal and trochlear region (ACA-252); distal portion of a left tarso-metatarsus (ACA-335); left tarsometatarsus, lacking extremities (ACA-951); a right tarsometatarsus, lacking extremities (ACA-952).

LOCALITY AND AGE. — Çalta, Department of Ankara, Turkey. Pliocene. MN15 Zone.

DESCRIPTIONS AND COMPARISONS
The avian collection from Çalta consists of three

femora, one tibiotarsus and three tarsometatarsi. All the bones are incomplete lacking their extremities which hinders comparative analysis with other fossils from the Eurasiatic region. Of the tarsometatarsi, a pair appears to have belonged to the same individual, while the third smaller one seems to have belonged to a young individual. The bones are fragile, especially the femora wherein the fragments are held in position by the fine compacted light reddish sediment filling the medullary cavity. At first sight they appear to belong to a large terrestrial bird, and detailed comparisons show that they are of a large-sized struthioniform bird.

Comparative material of *Struthio camelus* was obtained from the Laboratoire d'Anatomie comparée, Muséum national d'Histoire naturelle (MNHN); skeletons No. 1923-2163 and No. 1923-954. Additional comparative data on Miocene fossil ostriches described from Eurasia comes from Kurochkin & Lungu (1970), Burchak-Abramovich and Vekua (1990), and data on African fossil ostriches are from Arambourg (1979).

Femur (Figs 1-4)
Fragment ACA-949 is the diaphysial shaft of a left femur (Figs 1, 2). The anteroposterior thickness of the bone is 69.5 mm compared to 47 mm in an adult specimen of *Struthio camelus*, indicating a much larger femur than that of the common ostrich. Compared with recent ostrich data from Burchak-Abramovich & Vekua (1990, table 1, line 4), the measurements suggest that the femur belongs to a large and stout form of *Struthio*. The most salient features of this specimen are the origin of the *crista supracondylus medialis* running downwards and walling in the *fossa poplitea* as a large shallow groove, and the *linea intermuscularis caudalis* which is in continuation with the *crista supracondylus medialis*. The medial surface is flat and bears a faint but distinct muscular line. Normally in *Struthio camelus*, this line originates at the base of the great trochanter and runs transversely across the shaft to the anterior border of the external condyle.

Of the three femora, the small-sized specimen ACA-327 might have belonged to a young indivi-

TABLE 1. — Dimensions (in millimetres) of leg bones of *Struthio* sp. compared with *Struthio camelus*. Some data for *S. camelus* are from Burchak-Abramovich & Vekua (1990).

	Struthio sp. Çalta		*S. camelus*	
			MNHN 1923-954	Burchak-Abramovich & Vekua 1990
Anteroposterior thickness of diaphysis, left femur	ACA-949	69.5	47.0	35; 33; 36; 41; 47
Distal depth, left tarsometatarsus	ACA-335 young specimen	15.0	18.0	
Distal anteroposterior depth, left tarsometatarsus	ACA-951	22.2	17.3	
Distal anteroposterior depth, right tarsometatarsus	ACA-952	20.4	18.0	

dual. This fragment is the distal diaphysial part, devoid of the epiphyses (Fig. 3). However the diaphysis is quite evocative when compared to the larger ones, and belongs to a right femur. It is flat on its medial side and exhibits a crest which originates from the base of the trochanter major, the latter being absent in this specimen. The caudal margin is rounded in its upper part, becoming thinner as it gives rise to the *crista supracondylus medialis* which is partly preserved. The *condylus medialis* is absent as well as the *condylus lateralis*. The beginning of the popliteal fossa is visible on the caudo-lateral surface and the emergence of the bony shaft towards the lateral condyle is distinctive, as indicated in figure 3.

Specimen ACA-948 belongs to the lower portion of a right femur. The *fossa poplitea* is remarkably wide and deep, and in fact is larger than in *Struthio camelus*. It is bounded on its inner side by a rather sharp crest, the *crista supracondylus medialis*. The internal condyle is broken, and as can be seen in figure 4, it is shorter and less prominent than the external fibular condyle (*condylus lateralis*) which is also broken, but the bony shaft is obvious and significant. The external condyle protrudes further down than the internal condyle as in *S. camelus*. This femoral specimen appears to have been slightly deformed and its cross-section has roughly a four-sided angular shape, with a more convex zone corresponding to the external surface as in recent *Struthio*, while the internal surface is merely flat. The size of this bone is smaller than specimen ACA-949, the anteroposterior depth of the diaphysis being

58 mm, which is still greater than in the recent ostrich.

Tibiotarsus (Fig. 5)
One right tibiotarsus, ACA-950, is present in the lot (Fig. 5B) and consists of a linear shaft which tapers towards the distal end, and the epiphyses are absent. The medial margin is slightly curved inwards in the distal region. This bone is designated as a right tibiotarsus due to the presence of a distinctive medullary foramen on the lateral margin of the diaphysis. This foramen is localized in a more frontal than lateral position, and opens at the end of a furrow which in this bone is linear in shape (Fig. 5D). This furrow indicates the position of the nutritive medullary artery that enters the diaphysis. In *Struthio camelus*, this furrow is arched towards the front (Fig. 5A, C).

The transverse section of the bone is oval with an anteroposterior compression. In cross-section this shape is maintained all along the shaft, but with diminishing dimensions distally up to about 26 cm down the shaft after which it widens transversely. The cortex in this specimen is thicker than in any of the other bones, being about 5 mm thick. The median border bears a faint but noticeable smooth posterior ridge which runs along this side of the shaft until it reaches the concave underside. Following this, the margin expands internally to form the inner condyle of which only the beginning is preserved in this specimen. The contact zone with the fibula is depressed in the fossil, showing a shallow canal about 7 cm long. In *Struthio camelus*,

the fibular groove runs alongside the medullary furrow and foramen, then becomes evanescent and re-emerges further down the shaft and continues to the distal end of the shaft where it reaches the external condyle. This is not observable in the fossil specimen where the fibular groove stops just short of the position of the medullary foramen.
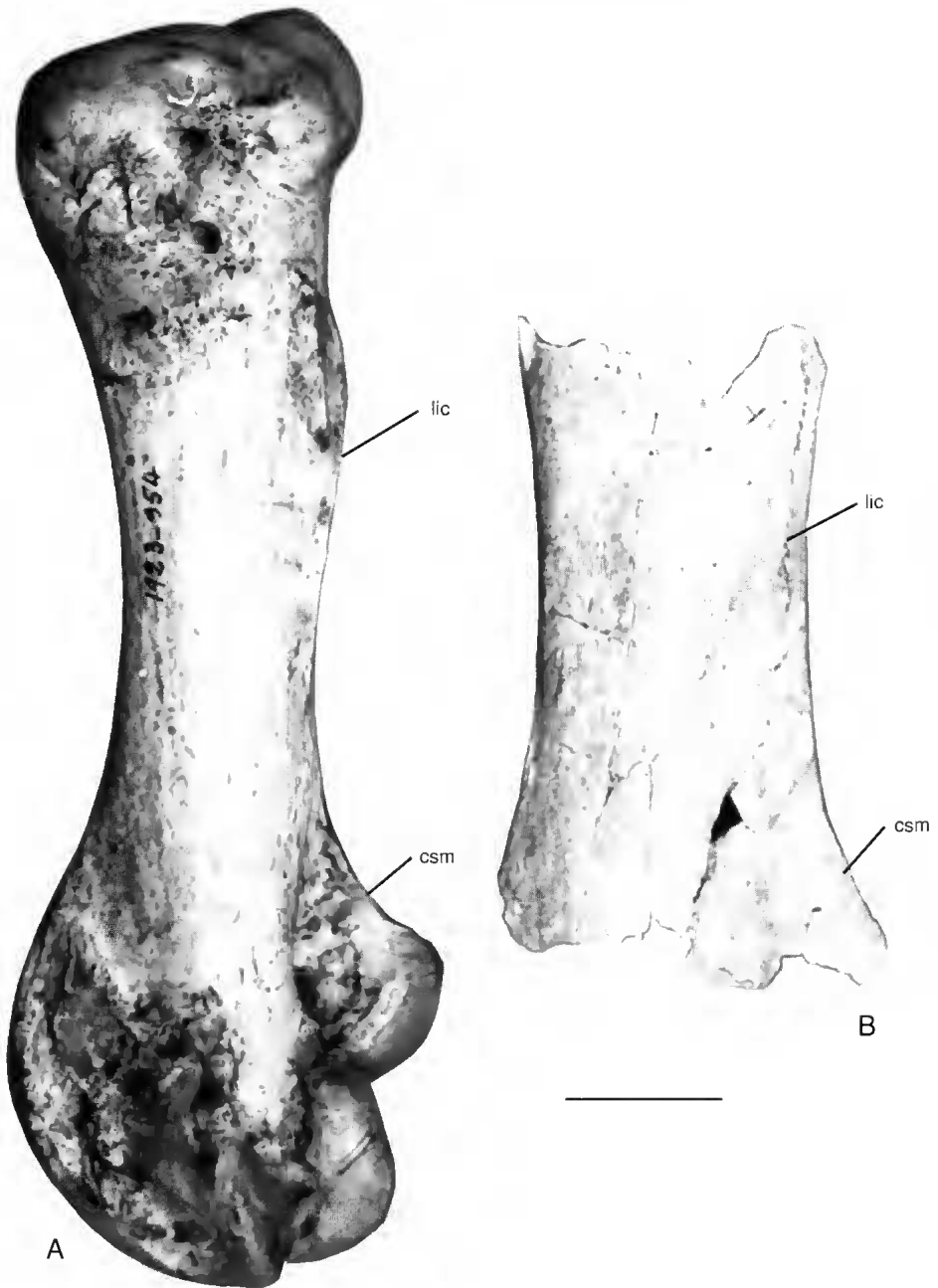

Fig. 1. — Comparison of left femur, lateral view; **A**, *Struthio camelus* (MNHN 1923-954); **B**, *Struthio* sp., Pliocene, Çalta (ACA-949). **lic**, *linea intermuscularis caudalis* ; **csm**, *crista supracondylus medialis*. Scale bar: 4 cm.

Tarsometatarsus (Figs 6-8)

The most characteristically identifiable bones of this collection are two tarsometatarsi, the right and the left, which apparently belong to the same individual (ACA-252: right, and ACA-951: left). Both are composed of the shaft only, the proximal and distal extremities having been lost. Nevertheless there are diagnostic characters indi-

FIG. 2. — Comparison of left femur, medial view; **A**, *Struthio camelus* (MNHN 1923-954); **B**, *Struthio* sp., Pliocene, Çalta (ACA-949). **li**, *linea intermuscularis cranialis*; **cm**, *crista medialis* of medial condyle. Scale bar: 4 cm.
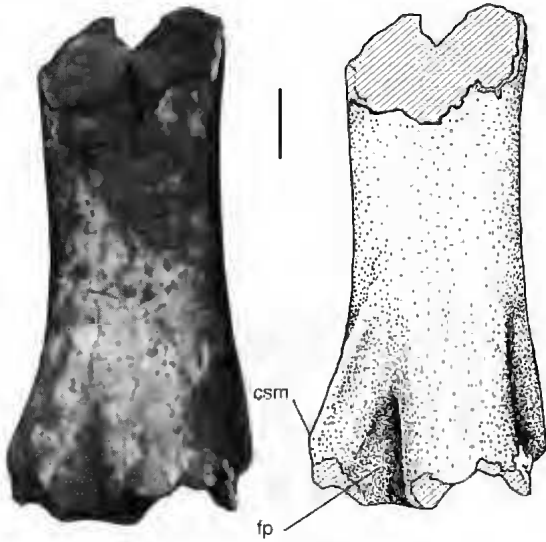
FIG. 3. — Right femur of *Struthio* sp., Pliocene, Çalta (ACA-327), posterior view. **csm**, *crista supracondylus medialis* ; **fp**, groove leading to the *fossa poplitea*. Scale bar: 2 cm.

cative of the struthioniform morphotype. The length and anterior morphology of the tarsometatarsus exclude any resemblance to the casuariform type in which the anterior tarsometatarsal groove is characterized by being deeply excavated and bordered by thick lateral walls giving a canal-like structure, and also by its extension along the shaft which is less in comparison with the total length.

In the Çalta specimens, the anterior tarsometatarsal groove is distinctive and is about 7 mm wide at mid-shaft level, but in comparison with *Struthio camelus*, its width is slightly narrower relative to the transverse tarsometatarsal width. In *Struthio*, this groove is very shallow and wider proximally with the lateral ridges being rather sharply individualized as they originate from the two proximal cotylae. In the Çalta tarsometatarsi, the curvature of the medial margin is very conspicuous at first sight, and one may suggest that there could have been some deformation as fossilization occurred. In fact, this curvature is very pronounced in comparison with the
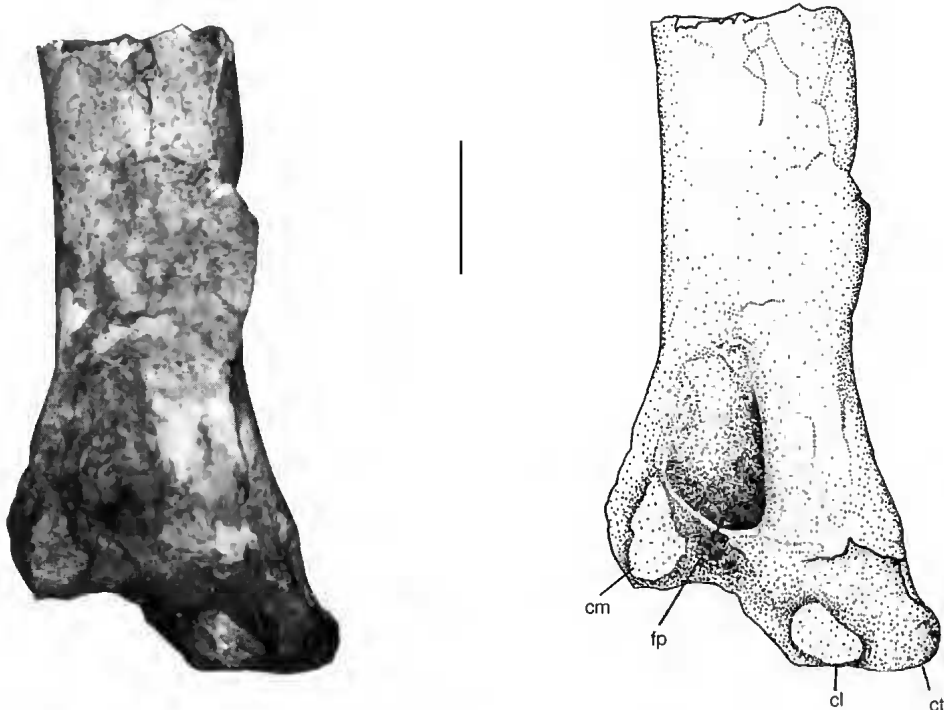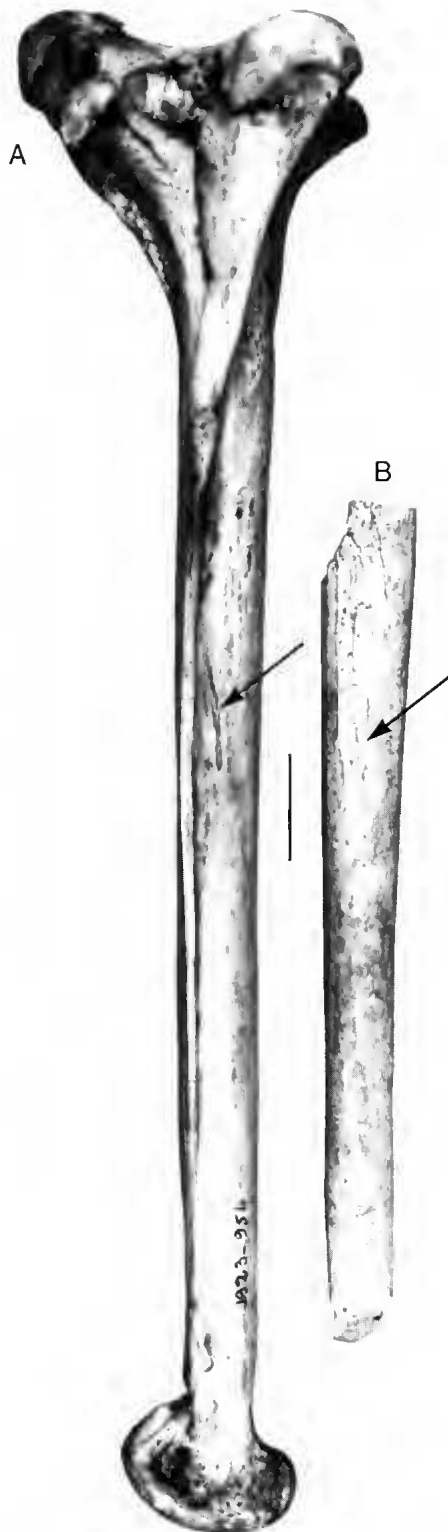

FIG. 4. — Right femur of *Struthio* sp., Pliocene, Çalta (ACA-948), posterior view. **cm**, *condylus medialis*; **cl**, *condylus lateralis*; **ct**, *crista tibiofibularis*; **fp**, *fossa poplitea*. Scale bar: 4 cm.

modern *S. camelus*, in which the tarsometatarsus is fairly linear, with a slight overall curvature along the diaphysis from the proximal to the trochlear region (Fig. 6). The fact that both tarsometatarsi from Çalta are curved similarly inwards suggests that they have not been deformed during fossilization. As can be seen from the lateral and medial views (Fig. 7), the tarsometatarsi exhibit a greater anteroposterior depth than in *S. camelus*, with a more pronounced hypotarsal crest. Also the tarsometatarsal shaft appears more compressed laterally than in *S. camelus*.

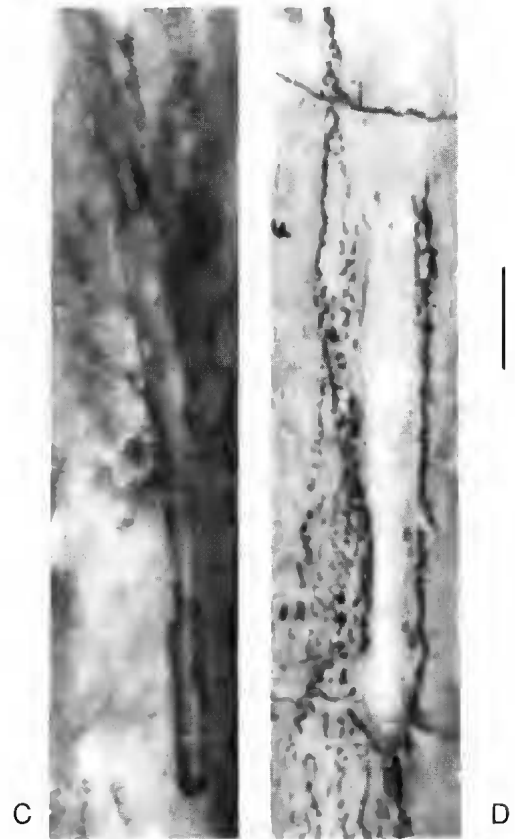The proximal ligamental attachment for the *musculus tibialis anticus*, is present in both the

FIG. 5. — **A, B**, right tibiotarsus, in lateral view; **A**, *Struthio camelus* (MNHN 1923-954); **B**, *Struthio* sp. (ACA-950) lacking epiphyses; arrows indicate the trajectory of the medullary groove which is linear in *Struthio* sp. but arched in *S. camelus*; **C, D**, medullary groove leading to the nutritive foramen localized on the external surface of the tibiotarsus in (**C**) *Struthio camelus* and in (**D**) *Struthio* sp. Scale bars: A, B, 4 cm; C, D, 0.5 cm.
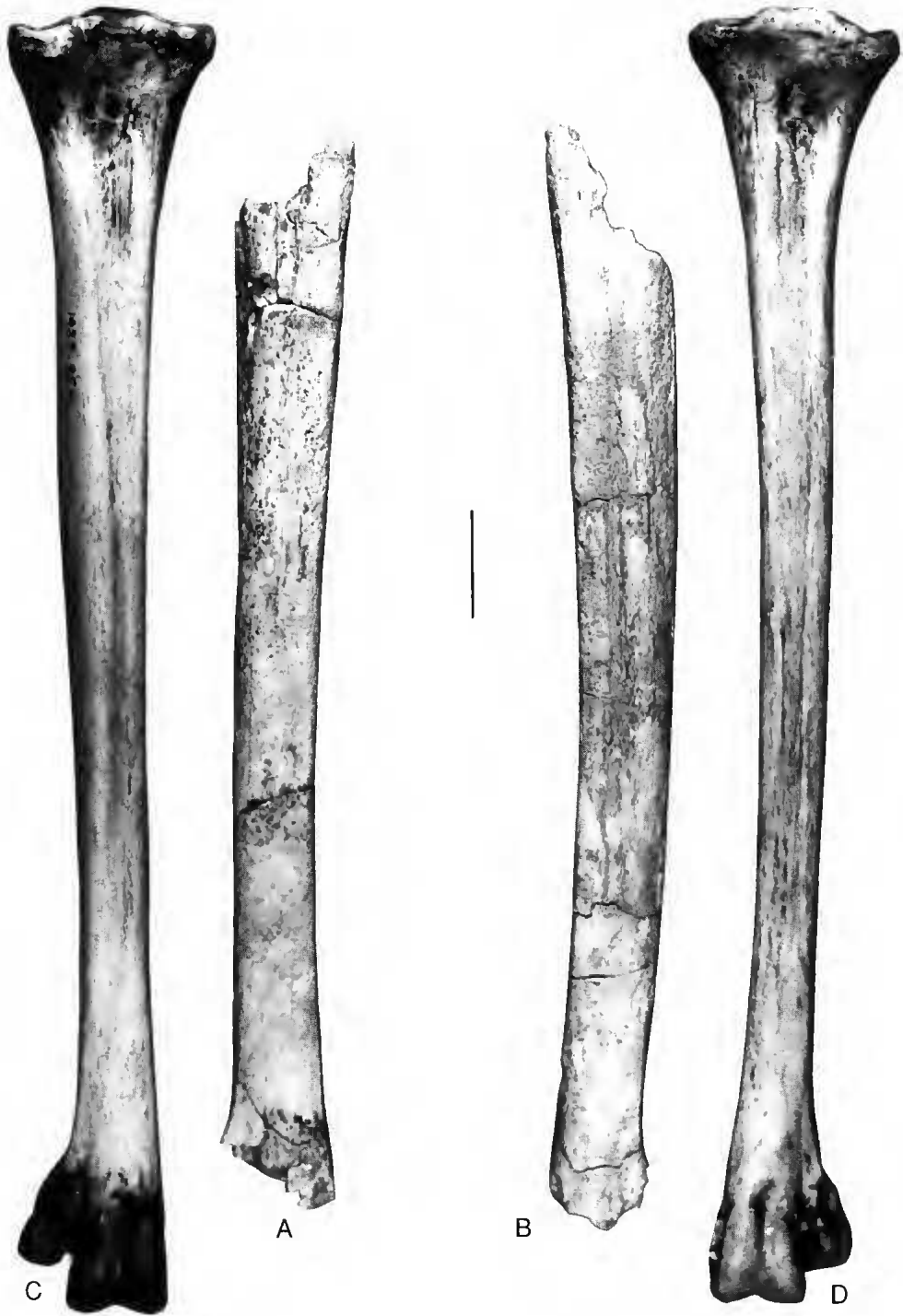
FIG. 6. — **A, B**, right (ACA-952) and left (ACA-951) tarsometatarsi of *Struthio* sp., Pliocene, Çalta; **C, D**, complete tarsometatarsi of *Struthio camelus* (MNHN 1923-954). Anterior view. Scale bar: 4 cm.
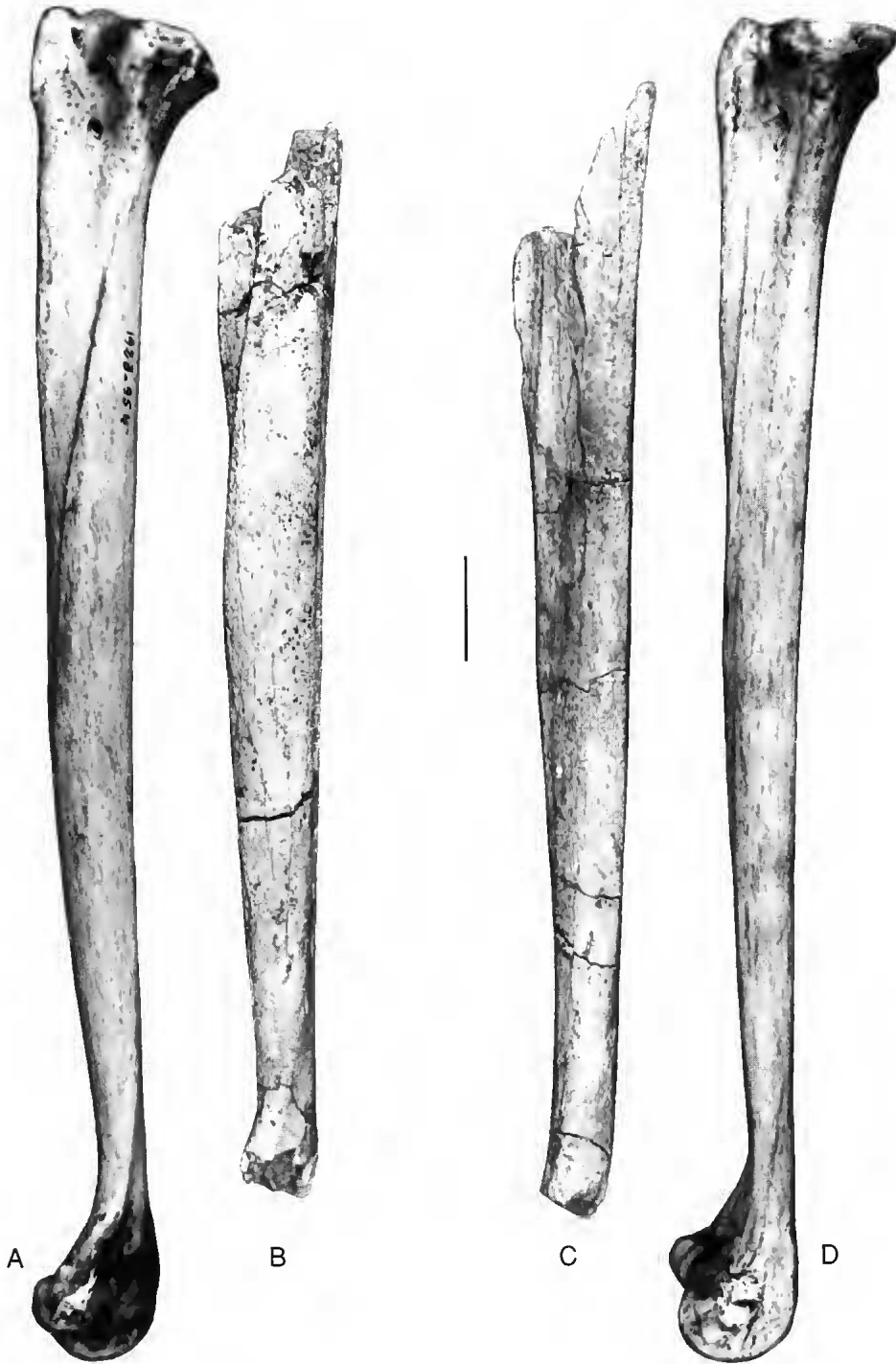
FIG. 7. — **A**, right tarsometatarsus of *Struthio camelus* (MNHN 1923-954), in lateral view; **B**, the same for *Struthio* sp., Pliocene, Çalta (ACA-252); **C**, left tarsometatarsus of *Struthio camelus*, in medial view; **D**, the same for *Struthio* sp., Pliocene, Çalta (ACA-951). Scale bar: 4 cm.
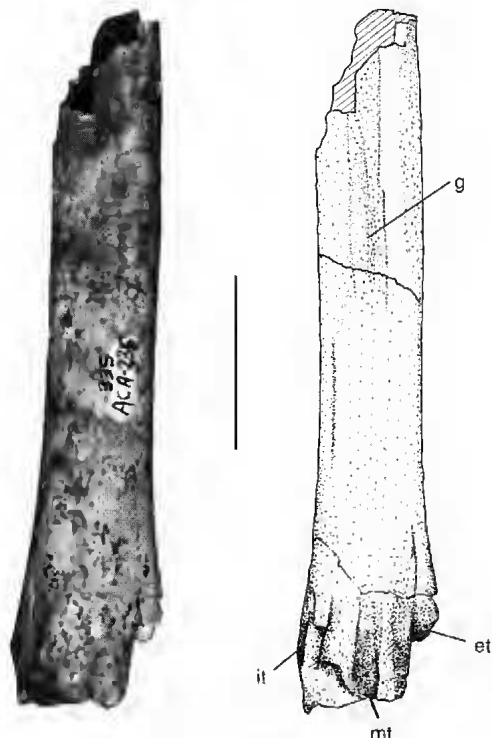
FIG. 8. — Anterior view of left tarsometatarsus of a young individual of *Struthio* sp., Çalta (ACA-335). **et**, external trochlea; **g**, anterior metatarsal groove; **it**, internal trochlea reduced to a stub; **mt**, middle trochlea. Scale bar: 4 cm

left and the right tarsometatarsi, appearing as a longitudinal tuberosity. As expressed above, the tarsometatarsi are curved medially and, in profile, they show a deeper anteroposterior depth (Fig. 7) than in the common ostrich. Also the width is greater than in the latter species. The middle crest which arises from the medial hypotarsal ridge in the recent form and which runs along the shaft up to about a third of its total length is visible in the fossil specimen, and it does not fuse with the two lateral crests (*cristae plantares medialis et lateralis*) which originate from the two cotylae. These crests are almost effaced in the Çalta tarsometatarsi. The external crest runs laterally on the surface of the shaft, and converges onto the median plane, meeting its counterpart from the other side and uniting with it in the distal region. The proximal part of this crest (*crista plantares lateralis*) is more arched in *S. camelus* than in the Çalta tarsometatarsus (Fig. 7A, B).

In cross section, the shaft is triangular in shape in *Struthio camelus* just as in the fossil specimens, but it is more compressed laterally in the latter. Also the fossil bone is more robust and is wider in its transverse dimension than in *Struthio camelus* giving the latter a relatively more gracile silhouette.

A third tarsometatarsus (ACA-335) is present in this collection, but it is of small size, corresponding evidently to the distal extremity of a young individual (Fig. 8). As in the larger bones, the trochlear region is missing, and because of the inward curvature of this specimen, it is diagnosed as a left tarsometatarsus. The anterior surface of the bone bears the shallow depression for the *tibialis anticus* muscle in its upper half, while the lower half is flat and expands anteriorly towards the median trochlea with, in between, the frontal depression of the articular groove. Moreover, a relic of the internal trochlea appears as a slight protuberance demarcated by a fine curved line from the middle of the shaft on the posterior concave surface. The external trochlea exists only as a distinct remnant emerging from the main shaft. Its origin lies much above the tuberosity corresponding to the extremely reduced inner trochlea.

DISCUSSION
Fossil ostrich bones have been described from numerous localities in Eurasia (Kurochkin & Lungu 1970) and in Africa (Arambourg 1979; Rich 1974). Kurochkin & Lungu (1970) assigned most of the Pliocene and Pleistocene specimens distributed from Eastern Europe to China, Transbaykalia and northern India to a single species *Struthio asiaticus*. They considered the latter to be a direct ancestor of the living species *Struthio camelus* and recognized only four species: *S. orlovi*, *S. brachydactylus*, *S. asiaticus* and the recent *S. camelus*. However, Burchak-Abramovich & Vekua (1990) do not seem to agree with this interpretation in their description of another fossil ostrich *S. dmanisensis* Burchak-Abramovich *et* Vekua, 1990 from the Pleistocene of eastern Georgia.

S. orlovi Kurochkin *et* Lungu, 1970 was erected on the basis of a distal fragment of a tibiotarsus. It cannot be compared with our material.

S. brachydactylus Burchak-Abramovich, 1949 is better known by a partial skeleton from Grebenniki in Ukraine. In size, we are only able to compare the minimum breadth of the leg bones, which seems to be of the same order. For example, the minimum transverse diameter of the tarsometatarsus is 3.3 mm in *S. brachydactylus* (Burchak-Abramovich 1949, table 1) in comparison with 32.7 mm and 33.3 mm as measured on adult specimens from Çalta. However the Çalta tarsometatarsi bear a concave internal margin, whilst the shaft of the same bone in *S. brachydactylus* is straight. Sauer (1979) referred to this species one phalanx and egg-shell remains from Çandir (MN6, Turkey).

S. karatheodoris Forsyth Major, 1888 was described from Samos (MN11-12, Greece) with a sternum and a femur. The latter specimen was not illustrated, but Forsyth Major (1888) described it as being larger than the living *S. camelus*. These specimens were apparently lost during the Second World War. Bachmayer & Zapfe (1962) referred to this species three distal fragments of the tibiotarsus and one phalanx. These are not comparable with the Çalta specimens.

The type specimens of *S. asiaticus* are from the Siwalik Hills in the Indian peninsula, and Lydekker (1884) described some leg bones including a tibiotarsus and the distal portion of a tarsometatarsus with the proximal portion of the first phalanx of the third digit. The Çalta tarsometatarsus closely resembles the right tarsometatarsus of the Siwalik Hills at least in the shape and dimensions of the distal extremity before the trochlea.

The type material of *Struthio dmaniensis* from the Pleistocene of eastern Georgia (Burchak-Abramovich & Vekua 1990) is a right femur of a large individual. The only comparable dimension is the smallest width of the diaphysis which measures 76 mm in the *S. dmaniensis* specimen *vs* 69.5 mm in the largest Çalta femur. This would indicate an intermediate size for the Çalta specimen between this species and *S. camelus*.

S. pannonicus Kretzoi, 1953 from the lower Pleistocene of Kislang, Hungary, is only known by a pedal phalanx.

Arambourg (1979) described *S. barbarus* from the early Pleistocene of Aïn Boucherit, Algeria, a species slightly larger than *S. camelus*, and represented by a tibiotarsus, fibula and a tarsometatarsus. In this species the section of the tibiotarsus is elliptical and the posterior face of the bone is rounded, as in the specimen ACA-950. However, the Çalta specimen represents a young individual and is consequently smaller.

Considering the available data listed above, it appears that firstly, the fossil materials from various localities are very fragmentary, and that secondly, adequate comparisons between the erected species have not been accomplished. A revision of the fossil ostriches of the Neogene of Africa and Eurasia is wanting. We suggest that due to the lack of conclusive criteria and also the fragmentary state of the Çalta fossils, we cannot attribute the latter to any known taxon.

CONCLUSIONS

This paper describes the struthioniform remains from Çalta. Despite the abundance of the material (portions of three femora, one tibiotarsus and three tarsometatarsus), its fragmentary nature does not authorize detailed comparison. Moreover, during this study, we noted that many *Struthio* species from the Neogene and Pleistocene of the Old World were erected on fragmentary remains, and their specific characteristics are not clearly highlightened. On the other hand, there is no recent study revising the systematics of this group.

Concerning the Çalta material, the differences in size and morphology we observed between the Çalta material and fossil and living species of *Struthio* are probably indicative of a new species, but due to the absence of complete and better preserved material, it seems preferable to leave the Çalta material in open nomenclature rather than to complicate the definition of a species which needs as yet a complete revision within a phylogenetic framework.

The biogeography of the ostriches has been discussed by several authors, with much emphasis on the centre of origin. The classical hypotheses regarding struthionid origins includes an Eurasian evolution prior to their spreading into Africa (Sauer & Rothe 1972; Houde 1986), but

it was primarily based upon the abundance of fossil remains in this area, despite these being rather fragmentary bones and eggshell remains. African struthious remains have been described by Lowe (1933), Arambourg (1979), Rich (1974, 1980) and Sauer & Sauer (1978). More recently, struthioniform skeletal and eggshell remains have been reported from the lower Miocene of Namibia (Mourer-Chauviré et al. 1996a, b), thus enlarging the biogeographical and temporal scope of the family Struthionidae.

The new struthioniform material from Central Anatolia indicates the abundance and wide distribution of ostriches in Eurasia during the Pliocene. The precise affinities of this species are not definable at the moment and is being designated as *Struthio* sp.

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